

Women Scientists and the Freshwater Biological Association, 1929-1950

M. D. TOOGOOD^A, C. F. J. WATERTON^B and M. W. HEIM^C

^A Historical Geography, University of Central Lancashire, Preston, PR1 2HE (e-mail mtoogood@uclan.ac.uk).

^B Centre for the Study of Environmental Change, Sociology Department, Lancaster University, LA1 4YT.

^C Low Wood, Haverthwaite, Ulverston, Cumbria, LA12 8LY.

ABSTRACT: In the early to mid-twentieth century, women had limited opportunities to develop and practice as scientists and were subject to being treated as exotic beings rather than on equal terms as their male counterparts. Opportunities in freshwater science arose in England in interconnected freshwater sciences, particularly in a number of interconnected institutions centred on the Freshwater Biological Association (FBA) founded in 1929 and in British colonial science. Several women scientists pioneering in their fields were nurtured by the FBA, such as early freshwater researchers, Penelope Jenkin, Marie Rosenberg and Winifred Frost, the last two being the first professional women naturalists at the FBA. Other researchers who achieved distinction in their field were also products of the FBA and its imperial and university network: Rosemary Lowe, Winifred Pennington, Kate Ricardo, Carmel Humphries and Maud Godward, for example.

KEY WORDS: Freshwater Biological Association – women scientists – imperial science – twentieth century – limnology – ichthyology

INTRODUCTION

In May 2014, the Royal Society hosted a conference on the theme of ‘Women in Science, 1830-2000’. The conference sought to revisit women’s participation in science, to open up historical research into the roles of women scientists and to reflect on how history can inform insight into the contemporary role of women in science. As the conference emphasised, the prevalent historical image of women scientists was, and perhaps still is, a caricature. A woman scientist was regarded foremost as an atypical woman: a superwoman, or a harridan,

for example; as forgoing her femininity; as something to be marvelled at. The conference also highlighted that the twentieth century was one in which the contribution of women in making science was largely invisible. The normal idea of scientific achievement being marked by the concept of the (male) individual ‘breaking through’ in a particular area of science was a construct which served to shut women out of the history of science. Women in the late nineteenth and early twentieth century were actually involved in making science, but typically as part of work in factories, museums, schools, military production and relatively small specialist organisations, rather than in places which society, as well as historians of science, have habitually associated with scientific accomplishment.

The conference came at a time when the authors of the present paper were beginning research in the archives of the Freshwater Biological Association (FBA), based at Far Sawry on Lake Windermere in the English Lake District. Our research sought to explore in detail some of the anecdotes about the culture of the FBA in the early twentieth century. It was said that it positively encouraged the training of women scientists and it employed a number of them in its core scientific staff. In fact, it seemed there were a number of women undertaking pioneering scientific work right from the organisation’s inception in 1929. This was in an age when women holding investigative scientific positions, particularly in grant-aided organisations such as the FBA, was highly unusual. Some of these women spent much of their career at the FBA and associated organisations in the British Empire, and many of them became innovators of new knowledge and techniques, furthering new understanding in freshwater sciences such as limnology, ichthyology and algology. Haworth is correct to say that these women became a new generation of respected researchers (2007).

In this paper, we focus on women scientists in the FBA at its first laboratory and in its wider international network in the British Empire during the inter-war and immediate post-war period. Our objective in doing so is to capture the growth of opportunities for women scientists as the freshwater sciences developed. There are other broad accounts of the history of freshwater science, but none that focus on women scientists (Talling 2008). We should state in brief that our approach to women in the FBA treats natural history and science as alive with historical, social, cultural and philosophical importance, alongside its scientific significance – and requiring interpretation as such (Daston 2008; Landecker 2016). In other words, science is a social phenomenon. The approach we adopt in our work also does not regard ‘gender’ as a determining category, as the scientific culture of the twentieth century

predominantly did, but as something that is the product of what is done within and organised through the institutions, assumptions and conventions of science (Schiebinger 1989; West and Zimmerman 1987; Benschop and Brouns 2003; Watts 2007). Therefore, we consider gender as something that is part of science, as it is of society more widely and, therefore, the history of the FBA as a place in which women were remarkable pioneering scientists amongst other pioneering scientists, not remarkable for being women, emphasises the shifts that science has made since the 1920s.

WOMEN AND SCIENCE IN ENGLAND – AN HISTORICAL OVERVIEW

In this section, we consider women's opportunities in science during the late nineteenth and early twentieth century. There was at the time a general idea that women were unsuited to intellectual pursuits and were far more suited to domestic spaces and work than to scientific work (Marsden and Omery 1992). Women at Birkbeck College were first permitted to attend scientific lectures in 1832. A movement to enable women to gain full entrance to higher education achieved its first success in 1869 when a woman could take the Cambridge University entrance examinations, leading to the foundation of women only institutions: Girton College in 1869 and Newnham College in 1871 (Richmond 1997). Although women could study science subjects and even take examinations in the Cambridge Natural Science Tripos, they could not be awarded a degree or become members of Cambridge or Oxford Universities until 1948 and 1920, respectively. In 1922 a Royal Commission upheld Cambridge's rejection of women as degree students (Dyhouse 1995). In science lectures at Cambridge the physical segregation of women was an unwritten rule and women would often be confined to a gallery or to certain rows of seating. They were not permitted to interact with lecturers (Richmond 1997).

In 1925, the Cambridge zoology undergraduate, Sidnie Manton, (elected FRS in 1948 on the basis of her research on arthropods), was denied the University Prize she would have won for coming top of the Part 2 zoology tripos because women could not be members of the university (Fryer 1980). Other universities did allow women to achieve degrees. London University, for example, first admitted women in 1878, and between 1900 and 1938, the proportion of women students rose steadily to about 25 per cent of the total (Dyhouse 1995, 17). Dr Nellie Eales was among the first women to graduate with a zoology degree in 1907.

She later worked at the Marine Biological Association in Plymouth and taught some women scientists associated with the FBA, such as Ethelwynn Trewavas.¹

There were examples that represent early educational opportunities for women in science, that run counter to the struggle for acceptance portrayed above. In 1903, Swanley Horticultural College in Kent (later to become part of Wye College, University of London), began an experiment to make its curriculum more scientific (a strategic move, partly to aid solutions to the agricultural depression at the time). As women students were achieving more highly in its science subjects, and its male students were largely receiving training for horticultural apprenticeships, it decided to adopt a policy to admit only female candidates (Optiz 2013). Another example is the Balfour Biological Laboratory for Women, established at Cambridge University between 1884-1914 (the year women were finally admitted to study in university laboratories). The Balfour Laboratory instructed women in the full range of biology so that they could effectively take tripos examinations, The Balfour Lab was especially significant after women were shut out of practical classes in 1886 (Richmond 1997, 447). The Balfour Laboratory became a locus for women scientists otherwise marginalised and often directly excluded from mainstream science and the scientific support system enjoyed by males. In effect the Balfour Laboratory in gave rise to a feminized scientific subculture, including women's scientific societies and women-sponsored college fellowships (Richmond 1997, 455).

Although women students were encouraged to maintain their studies during the First World War, the rush of women into war work was not reflected in increased permanent opportunity in the sciences. As Fara puts it, “[w]hile male university students were dying at the Front, their female counterparts were treated like children” in being assigned menial and repetitive tasks that underemployed their abilities (2014, 16). Despite the widespread image of women being set free from domesticity by the First World War only a very few experienced the scientific liberty afforded to men, and the status quo was quickly re-established after the Armistice (Fara 2014, 12).

Given that at least twenty women were working or training at the FBA in its early years (from 1929 onwards)², it is right to ask whether a distinctive social and institutional culture may have developed there that, at least in some respects, disregarded gender distinction. The first degree programme in freshwater biology in Britain was started at Cambridge by J T Saunders, with Barton Worthington (first director of the FBA) and Penelope Jenkin, (an early

FBA researcher), being part of the initial cohort of graduates in 1925 – although Jenkin would have received a certificate rather than a degree. Jenkin was perhaps the first student to finish Saunders' course on hydrobiology (Slack 2010, 143).

However, overt discrimination against women such as barring them from membership of scientific organisations, and requiring married women to resign limited their career options. The later discrimination applied to civil service and academic science. In 1928, for example, the academic Dr Kathleen Drew (later the founder and the first President of the British Phycological Society), was obliged to leave her lectureship at Manchester University when she married, whilst her husband was able to retain his academic post (Brodie 2010). Therefore, we can ask whether the FBA, or perhaps networks of freshwater science more broadly, opened up institutional norms, broadening women's opportunities to take on scientific roles (Madsen-Brooks 2009).

WOMEN AND THE FRESHWATER BIOLOGICAL ASSOCIATION

The Freshwater Biological Association of the British Empire, was established in 1929.³ It was funded by the Development Commission, private subscriptions, some university assistance, and the support of bodies from the water industry. Its stated aim was to 'prosecute research into the fundamental problems of freshwater biology' through the establishment of a British research station with accommodation and a laboratory (FBA 1933), although the Development Commission later favoured applied research. The FBA was first headquartered at Wray Castle, a crenelated, gothic revival property, built in 1840 on the north-western shore of Lake Windermere.⁴ In 1929 the National Trust took possession of Wray Castle and immediately leased it to the FBA, thus establishing a research station based on the one set up by the Hungarian government on Lake Balaton (FBA 1930). The staff of the new organisation started to alter the space to accommodate several laboratories as well as residential space for researchers and visitors.

One of the early customs that contributed to a distinctive research culture at the FBA was that of the annual Easter Class for students. The Annual Report of the FBA Council published in the summer of 1933 gives a feel for how these classes began and how they fed into the research at FBA:

The Council considered that such a class would bring to the notice of the Universities the facilities of the Laboratory and would also encourage young students to undertake

research in freshwater problems. Dr Pearsall, Mr Saunders and the staff expressed their willingness to conduct a class during a fortnight of the Easter Vacation. Notices of the class were sent to all the Universities and University Colleges in Great Britain and Ireland and an embarrassing number of applications to attend was received. The original proposal was to have a class of six students, but the number of applications made it desirable to increase this number and thirteen students were, with difficulty, accommodated. Thirteen applications had to be refused. Seven Universities were represented in the class, and, in spite of the crowded conditions and rather unfavourable weather, it proved a great success.

(FBA 1933, 12)

These classes attracted many male and female students and there seems to have been a distinct lack of scientific hierarchy. The classes were not a matter of a senior member of FBA staff dispensing knowledge they involved all participants in doing science. Students might, for example, initiate and carry out a detailed survey of a stream, looking at the chemical, biological and physical characteristics and creating scientific evidence and analysis. In fact, two of these students, Miss QE Hobbs and Miss EM Oliver, worked on soluble nitrogen and species presence in streams in 1932 (FBA 1933). The following year, 30 percent of the FBA research projects being carried out were being undertaken exclusively by female scientists. Miss CM Humphries of University College Dublin, for example, conducted a research project on chironomid larvae, and Miss M Vincent of Cambridge University conducted research on mosquito larvae. Miss MB Godward of East London College studied shore algae, Miss FM Willis studied photosynthesis under changing light conditions, whilst Miss QE Hobbs continued her stream work from the previous year and showed that the chemical composition of water in streams varied within a short distance. (FBA 1933, 8).

At least two of the above students went on to become prominent in their field. Maud Godward received a fellowship through Fritsch for postgraduate work at the FBA. After that, and via a series of short-term academic contracts, she secured a botany lectureship at Queen Mary's College, University of London. As a former student of Fritsch she could, apparently, be relied upon to deliver the specific subject matter to the high level that Fritsch considered a requirement of a biology degree. Ultimately, Godward became Professor of Phycology at Queen Mary College (QMC), also serving as Vice-President of the British Phycology Society. Godward Square on the QMC Mile End site in London is named after her.

A second example of a successful academic career is Carmel Humphries. She received a grant for residential study at Wray for the year 1934-5 conducting research on benthic fauna

(with Winifred Frost – an ichthyologist), and publishing her work in the *Journal of Animal Ecology* (Humphries 1936). After joining University College Dublin as a lecturer in 1939, she continued her work on Chironomidae initiated at the FBA. In 1957 Humphries was appointed head of school and professor of zoology at UCD.⁵ The chironomid, *Zalutschia humphriesiae* is named after her.

Most of these of these researchers were students who went on to undertake funded research at the FBA. Many of those came from universities with Cambridge University and London University the most prominent.. The reason for these universities sending many students was the fact that academics held council positions with the FBA. The link to Cambridge was John Saunders who was a senior member of the Botany Department's academic staff. Felix Fritsch, was professor of Botany at the East End College (which became QMC in 1934). Both Saunders and Fritsch were key members of the British Association committee that in 1928 helped drive the argument for the need for a freshwater biological station in Britain, Fritsch using his Presidential speech at Leeds in 1927 to make the argument (Fritsch 1937, 33). The other key figure central to the influx of students in the FBA's early years was William Pearsall. Pearsall was a Reader in Botany at the University of Leeds. Between 1931 and 1937, he was Honorary Laboratory Director of the FBA, and became President of the British Ecological Society in 1936 (FBA 1938). Pearsall vacated the honorary post only on his appointment as Professor of Botany at Sheffield University in 1937.

Both of the first professional naturalists at Wray Castle were research students supervised by Saunders at Cambridge. They were Philip 'Pip' Ulllyott (Naturalist-in-Charge) and Bobby Beauchamp (Assistant Naturalist). In 1932, immediately before Ulllyott and Beauchamp took up their appointments they went travelling together in Finland. Whilst they were there Penelope Jenkin arrived to work on the chemical composition of lake water in different seasons and also on the zooplankton of Lake Windermere (Macan nd, Lund 1984). The fact that the first naturalist to conduct any systematic work at the FBA was a female might not have been a simple coincidence. Jenkin was the more experienced Saunders protégé, and had demonstrated her abilities, not least as a member of the 1929 expedition to study the soda lakes of Kenya (Jenkin 1936).

Another important female scientist during the FBA's early years was Marie Rosenberg. She arrived at Wray Castle from Birkbeck College in 1934 to conduct research into the filamentous growth of algae, becoming a resident researcher from April 1935 (FBA 1936).

In January 1938, she was appointed as the Naturalist in Algology at the FBA, the first female to obtain a permanent naturalist position. However, Rosenberg's status as a refugee (she had originally left Berlin to escape Nazi persecution), led to her removal from active research despite the efforts of her FBA colleagues to prevent it. In summer 1939, she was informed that she would in due course receive naturalization papers. However, on 10 May 1940, the day the German army attacked France, the Netherlands and Belgium, a police car arrived at Wray to take Rosie and two Austrian house staff working at Barton Worthington's house away and into internment (Macan nd, 22). On her release after a year's confinement, partly due to FBA staff objections, she was as a foreign alien, officially forbidden from residing in a coastal county (Wray Castle was then in Lancashire), and her research was effectively halted. She later moved to Cambridge to work at Saunder's laboratory.

The ichthyologist, Winifred Frost was appointed the second full-time female Naturalist at the FBA, joining in February 1939 (FBA 1939). Frost is known for her work on eels (*Anguilla anguilla*). During World War II, Winifred Frost and her full-time assistant, Rosemary Lowe, were asked by the War Office to look at the commercial trapping of eels as a food source (Frost 1945, 1946; Bagenal 1970). Their work extended well beyond this applied focus to include a sensitive and thorough understanding of the natural history and biology of the eel. Their research was also experimental, using home-made novel experimental apparatus – such as the tank for testing elvers' responses to light. The tank they used – known as 'the River Styx' was situated in the basement of Wray Castle.⁶ During the war WEF, as Frost was known, became the only permanent member of scientific staff left at Wray Castle due to other male scientists enlisting for active duty. Winifred Frost went on to work on a number of fish species, notably becoming a globally recognised expert on game species particularly for her work with Charlotte Kipling from Newnham College.⁷ The culmination of this focus was *The Trout*, a work that took 20 years of research and writing with Margaret Brown (Frost and Brown 1967).

In 1936, Winifred Pennington, from Barrow in Furness, not far from Windermere, approached Mr Beauchamp, then the Naturalist-in-Charge, about using her vacation from Reading University to work on a series of projects at Wray Castle. She received a very warm welcome (Lund 1984). She became a prolific researcher – similar to other women resident at the Laboratory and fitted in accordingly. Her research included work on the anatomy of

Fucus (Pennington 1937), stream mosses (Pennington 1949), and the red freshwater algae *Hildenbrandia*. She also discovered a new coccoid algae genus, *Diogenes* whilst conducting experimental investigation of the utilisation of nitrogen by lake algae (Pennington 1942). It was her attendance at the 1941 Easter class that led to a transformation in her interest away from algology and, according to John Lund, formed “the seedbed for the flowering of British limnology” (1984, 2).

Pennington’s initial work on lake sediments was mostly inspired by the botanist Harry Godwin at Cambridge and also by her colleagues Clifford Mortimer and, later, John Mackereth at the FBA. Another important colleague at the FBA was William Pearsall with whom she wrote an ‘amazingly perceptive’ (Birks and Birks 2007, 603) paper on the natural history of the Lakes (Pearsall and Pennington 1947). After Pearsall’s death, she used his plan and notes to write *The Lake District* (Pearsall and Pennington 1973).⁸ Her work supplies evidence of a general sequence of late and post-glacial vegetational changes, thereby pioneering the field of paleolimnology (Pennington 1943, 1947). In 1942, she married a fellow botanist she had met at Wray Castle, Thomas Tutin. She did relocate from Wray to Cambridge University Botany Department in 1944 but returned to serve on the FBA Council 1958-1967 and joined the FBA staff in 1967 as a Principal Scientific Officer to work on lake sediments, forming her own Quaternary Research Unit.⁹ The credibility and reach of this research had genuine resonance evidenced in part by the fact that some of the most eminent freshwater scientists of the time, such as Evelyn Hutchinson, made study visits (Slack 2010, 144).

Two other Fritsch protégés were notable for a creative collaboration on microscopical algology from 1943 onwards. Hilda Canter became an important pioneer of photomicrography of algae working at the FBA, first as a PhD student, then as mycologist from 1948. She, John Lund (then holding the FBA position of Algologist, also from QMC), and the assistant algologist, Brenda Knudson, built up of specialist algology team at the FBA after the war. One of these areas of research in this general area was microbiological: understanding the fundamental links between fundamental research in bacteriology and how these applied to freshwater management, particularly in the water industry. From 1947 Vera Collins was working in this area, again leading research and pioneering the application to practical issues (Collins 1964).

IMPERIAL SCIENTIFIC OPPORTUNITIES FOR WOMEN

The FBA was tied into a wider international network of colonial science and institutions which provided a context for women scientists to find opportunities. The complex and ambitious African Research Survey overseen by Lord Hailey, 1929-1938, was influential in pioneering new directions for freshwater science. This came about partly through the Survey placing science at the centre of solutions to African problems and its identification of future research needs to underpin solutions. Julian Huxley, one of the instigators of the African Survey, was very conscious of the need for new science to become involved in identifying and dealing with African 'problems' such as food supply. It was Huxley who secured Barton Worthington as the scientific director for the Survey (Worthington 1990). Worthington went on to become the first Director proper of the Freshwater Biological Association of the British Empire (between 1937 and 1946), and, after Parliament passed the Colonial Development and Welfare Act (1940), Worthington became the Secretary of the then new Colonial Research Committee (CRC) which drove forward regional scientific research in East Africa between 1946 and 1951. Worthington was foremost in arguing that fish from inshore freshwater sources in colonial Africa was an underdeveloped resource (Worthington 1943). Long-range research initiatives, including into fisheries in Africa were put in place through the establishment of the Colonial Development Fund in 1929. They were further enhanced after the 1938 African Survey and the 1940 Colonial Development and Welfare Act that directly led to the creation of the CRC and of a Colonial Development and Welfare Fund (CDWF) and, in 1943 a Colonial Fisheries Advisory Committee (Hodge 2007, 106; Worthington 1943, 355).

It is also relevant that scientists had found opportunities in colonial research before finding openings in Britain. Examples are Penelope Jenkin with the Percy Standen expedition to Kenya in 1929 and Stella Worthington to Uganda and Kenya in 1927-28 and 1930-31 (Worthington and Worthington 1933). In 1939, a survey of Lake Nyasa involved Kate Ricardo (then doing research at the FBA) and Ethelwynn Trewavas (of the British Museum Natural History, hereafter BMNH) (Bertram et al 1942). A follow up to this expedition focusing on research into the fishes of Nyasaland took place in 1945, the principal researcher being Rosemary Lowe who had worked on the eel project under Winifred Frost.

The East African Fisheries Research Organisation (EAFRO) at Jinja in Uganda on Lake Victoria, was originally conceived by Barton Worthington and Michael Graham in 1929 and was set up in 1947 [CHECK] as a regional centre based on Worthington's model of a network of institutions sharing staff in England and Africa (Worthington 1983; Worthington 1943). This station has been described as the African arm of the FBA. In March 1948, Winfred Frost was seconded from the FBA at the behest of the Colonial Office to spend six months at Jinja to help establish a research programme for the EAFRO then coming into being (FBA 1948). The Director of this new organisation was Bobby Beauchamp, formerly the FBA's first Naturalist-in-Charge. Other women freshwater scientists working at EAFRO during its early days with connections to the FBA were Peggy Varley (1950-1951) and Mouse Osmaston. After a sojourn back at Wray Castle, in 1947 Rosemary Lowe successfully interviewed for a post with the then new Overseas Research Service (ORS). Her posting was to EAFRO where "her remit was to study the biology and fisheries potential of tilapias in the East African lakes, a task she undertook with remarkable skill and ecological acumen" (Stiassny and Kaufman 2015, 1719; Lowe-McConnell 1975). Lowe's field study gave a thorough account of the tilapia fisheries in East Africa and formed the basis of subsequent studies of Malawian cichlids (Bruton 1994). Lowe's work also was considered to have "revolutionized global studies on freshwater ecosystems and fish production" (Reid 2016, 443).

Those women scientists in the ORS who married were expected to resign, an example being Rosemary Lowe-McConnell who had to resign from the Colonial Service on her marriage in 1953, despite the marriage bar being lifted in the home Civil Service in 1946 (Bruton 1994, 71). In 1997 after she received the Linnean Medal of Zoology for her life time of scientific achievement in ichthyology, Lowe-McConnell commented, "not bad for someone who hasn't had a job since 1953!" (quoted in Stiassny and Kaufman 2015, 1722).

CONCLUSION

The FBA was established a year after electoral equality for women was achieved by the passage of the Representation of the People (Equal Franchise) Act 1928. This equality of franchise was not generally reflected in scientific institutions. As Des Jardins demonstrates most women scientists were dissuaded from lab and field research and frequently were

encouraged into ‘suitable’ occupations such as teaching, librarianship and editing – and especially “mundane tasks that would bore men with similar credentials” (2010, 127).

Some male scientists in the FBA were known to disparage women (such as Pip Ullyott – Macan nd). But it is notable that at the FBA all unmarried scientists lived and worked together as a community, the same seems true of the EAFRO in Uganda. It seems that the FBA was a pocket of difference in an environment in which men were appointed above women as a matter of course. Ethelwynn Trewavas suggests that women were treated more equally in the freshwater sciences because they, like their male colleagues, were all specialists, all had something relevant to contribute to both the advancement of freshwater sciences as a whole, and to the institutions they worked in (Noakes 1994, 63). Men did dominate the management and Board positions of the FBA, yet women scientists, such as Marie Rosenberg and Winifred Frost, were appointed to senior naturalist positions, something which was rare in scientific institutions for a long-time after the Second World War. Freshwater science was first and foremost a community of scientists, rather than a culture divided on gender which elevated male members to the rank of scientific heroes and female scientists to the caricature of extraordinary women.

ACKNOWLEDGEMENTS

We would like to thank the council and the staff of the FBA for their support and collegiality, particularly Dr Isabelle Charmantier (now at the Linnean Society); Dr Bill Bryson (FBA Chief Executive); Dr Anne Powell, and Dr Elizabeth Howarth. Thanks also to Gina Douglas for the invitation to present a paper to the SHNH annual conference 2017.

REFERENCES

- BAGENAL, T.B., 1970 An historical review of the fish and fisheries investigations of the Freshwater Biological Association, mainly at the Windermere Laboratory. *Journal of Fish Biology* **2** (2): 83-101.
- BENSCHOP Y. and BROUNS M., 2003 Crumbling ivory towers: academic organizing and its gender effects. *Gender, Work and Organization*, **10**: 94-212.

- BERTRAM, K, BORLEY, J. AND TREWAVAS, E. 1942 *Report on the fish and fisheries of Lake Nyasa*. London.
- BIRKS, H.J.B. and BIRKS, H.H. 2007 Winifred Tutin (1915-2007). *Journal of Paleolimnology* **38**: 601-605.
- BRODIE, J. 2010 Drew [married name Baker], Kathleen (1901-1957). *Oxford Dictionary of National Biography* doi.org/10.1093/ref:odnb/94193
- BRUTON, M 1994 The life and work of Rosemary Lowe-McConnell: pioneer of tropical fish ecology. *Environmental Biology of Fishes* **41**, 67-80.
- COLLINS, V.G. 1964 The fresh water environment and its significance in industry. *Journal of Applied Bacteriology* **27** (1): 143-150.
- DASTON, L., 2008 On scientific observation. *Isis* **99**: 97-110.
- DES JARDINS, J. 2010 *The Madame Curie complex: the hidden history of women in science*. New York City.
- DYHOUSE, C., 1995 *No distinction of sex? Women in British universities, 1870-1939*. London.
- FARA, P., 2015 Women, science and suffrage in World War I. *Notes and Records: The Royal Society Journal of the History of Science* **69**: 11-24.
- FOGG, G.E., 1979 *The Freshwater Biological Association 1929-1979. The first fifty years*. Ambleside.
- FOX, M. F., 1999 Gender, hierarchy, and science, pp 441-457 in: Chafetz, J.S. (editor), *Handbook of the sociology of gender*. New York City.
- FROST, W. E. and BROWN, M. E., 1967 *The trout*. London.
- FRESHWATER BIOLOGICAL ASSOCIATION OF THE BRITISH EMPIRE, 1930 *Report of the conference held at Fishmongers' Hall on Friday, February 21st, 1930*. Ambleside.
- FRESHWATER BIOLOGICAL ASSOCIATION OF THE BRITISH EMPIRE, 1933 *Report of Council, Subscription List and Accounts for 1932*. Ambleside.
- FRESHWATER BIOLOGICAL ASSOCIATION OF THE BRITISH EMPIRE, 1948 *Sixteenth Annual Report of Council, Subscription List and Accounts for Year Ending 31 March 1948*. Ambleside.
- FRITSCH, F, 1937 The early history of the Association, pp 33-41 in: Freshwater Association of the British Empire, *Seventh Annual Report of Council, Subscription List and Accounts for Year Ending 31 March 1937*.

- FRITSCH, F., 1951 The Windermere Laboratory of the Freshwater Biological Association. *Hydrobiologia* **3** (3): 293-296.
- FROST, W.E., 1945 The age and growth of eels (*Anguilla anguilla*) from the Windermere catchment area. *Journal of Animal Ecology* **14** (1): 26-36.
- FROST, W.E., 1946 Observations on the food of eels (*Anguilla anguilla*) from the Windermere catchment area. *Journal of Animal Ecology* **15** (1): 43-53.
- FRYER, G., 1980 Sidnie Milana Manton, 1902-1979. *Biogr. Mem. Fellows R. Soc.*, **26**: 327-356.
- HAWORTH E. 2007 Winifred Tutin. *The Independent* 23 May.
- HODGE, J., 2007 *Triumph of the expert: agrarian doctrines of development and the legacies of British colonialism*. Athens, Ohio.
- HUMPHRIES, C.F., 1936 An investigation of the profundal and sublittoral fauna of Windermere. *Journal of Animal Ecology*. **5** (1): 29-52.
- JENKIN, P.M., 1936 Reports of the Percy Slader expedition to some Rift Valley lakes in Kenya in 1929. VII Summary of the ecological results, with special reference to the alkaline lakes, *Journal of Natural History* **18** (103): 133-179.
- JONES, C. and HAWKINS C., 2015 Guest editorial – women and science. *Notes and Records: The Royal Society Journal of the History of Science* **69**: 5-9.
- LANDECKER, H., 2016 Antibiotic resistance and the biology of history. *Body and Society* **22**: 9-52.
- LOWE-McCONNELL, R., 1975 *Fish communities in tropical freshwaters: their distribution, ecology and evolution*. London.
- LOWE-McCONNELL, R., 2006 *The Tilapia trail: the life story of a fish biologist*. Ascot.
- LUND, J. 1984 Winifred Tutin: a personal note. pp 1–10 in E. Y. HAWORTH and J. W. G. LUND (editors), *Lake sediments and environmental history*, Leicester.
- MADSEN-BROOKS, L., 2009 Challenging science as usual: women's participation in American Natural History Museum work, 1870-1950. *Journal of Women's History* **21**: 11-38.
- MARSDEN, C. and OMERY, A., 1992 Women, science, and a women's science. *Women's Studies* **21**: 479-489.
- NOAKES, D.L.G. 1994 An interview with Ethelwyn Trewavas. *Environmental Biology of Fishes* **41**, 63-65.
- OPTIZ, D.L., 2013 'A triumph of brains over brute': women and science at the Horticultural College, Swanley 1890-1910. *Isis* **104** (1):30-62.

- PEARSALL, W.H. and PENNINGTON, W. 1947 The ecological history of the English Lake District. *Journal of Ecology* **34**: 137-148.
- PEARSALL, W.H. and PENNINGTON, W. 1973 *The Lake District*. London.
- PENNINGTON, W. 1937 The secondary thickening of *Fucus*. *New Phytologist* **36**: 267-279.
- PENNINGTON, W. 1942 Experiments on the utilisation of nitrogen in fresh waters. *Journal of Ecology* **30**: 326-240.
- PENNINGTON, W. 1943 Lake sediments: the bottom deposits of the North Basin of Windermere, with special reference to the diatom succession. *New Phytologist* **42**: 1-27.
- PENNINGTON, W. 1947 Studies on the post-glacial history of British vegetation VIII. Lake sediments: pollen diagrams from the bottom deposits of the North Basin of Windermere. *Philosophical Transactions of the Royal Society B* **233**: 137-175.
- PENNINGTON, W. 1949 The ecology of a Lakeland stream. *Transactions of the British Bryological Society* **1**: 166-171.
- REID, G. McGr. 2016 Obituary. Rosemary Lowe-McConnell 1921–2014 (Freshwater Biological Association and British Museum of Natural History). *Journal of Fish Biology* **88**: 443-447.
- RICHMOND, M.L., 1997 'A lab of one's own'. The Balfour Biological Laboratory for Women at Cambridge University, 1884-1914. *Isis* **88** (3): 422-455.
- SCHIEBINGER L., 1989 *The mind has no sex: women in the origins of modern science*. Cambridge, Massachusetts.
- SLACK, N., 2010 *G. Evelyn Hutchinson and the invention of modern ecology*. New Haven, Connecticut.
- STIASSNY, M. and KAUFMAN, L, 2015 Rosemary Lowe-McConnell, obituary. *Environmental Biology of Fishes* **98**: 1719-1722.
- TALLING, J.F. 2008 The developmental history of inland-water science. *Freshwater Reviews* **1**: 119-141.
- VARDI, I. and SMITH-DOERR, L., 2014 Women in the knowledge economy: understanding gender inequality through the lens of collaboration, pp 388-405 in KLEINMAN, D. L. and MOORE, K. (editors), *The Routledge handbook of science technology, and society*. London.
- VON OERTZEN, C., RENTETZI, M., and WATKINS, E., 2013 Finding science in surprising places: gender and the geography of scientific knowledge. *Centaur* **55**: 73-80.
- WATTS, R., 2007 *Women in science: a social and cultural history*. London.

- WEST, C. and ZIMMERMAN, D., 1987 Doing gender. *Gender and Society* **1**: 125–51.
- WORTHINGTON, E., 1943 Freshwater fisheries in the British colonial empire. *Nature*, 3830: 353-355.
- WORTHINGTON, E., 1983 *The ecological century: a personal appraisal*. Oxford.
- WORTHINGTON, E., 1990 Lord Hailey on the African Survey: some comments. *African Affairs* **89** (357): 579-583.
- WORTHINGTON, S. and WORTHINGTON, E., 1933 *Inland waters of Africa. The result of two expeditions to the Great Lakes of Kenya and Uganda, with accounts of their biology, native tribes and development*. London.

Illustrations

Figure 1. Easter Class, 1941. Author: unknown. Copyright of and reproduced with the permission of the Freshwater Biological Association, Far Sawrey, Windermere.

Figure 2. Dr Penelope Jenkin and the Jenkin Corer, c.1940. Author: unknown. Copyright of and reproduced with the permission of the Freshwater Biological Association, Far Sawrey, Windermere.

Figure 3. Dr Winifred Frost at Bils Tarn, 1941. Author: unknown. Copyright of and reproduced with the permission of the Freshwater Biological Association, Far Sawrey, Windermere.

Notes

¹ Trewavas was first appointed to the FBA Council in 1943. FBA Council papers 1943, Freshwater Biological Association archives (hereafter FBA arch.).

² FBA arch., calculated from 1929-1940, based on staff lists in FBA annual reports.

³ As it was called for its first 20 years. The change of name came about in 1947-48. This was followed by the FBA relocating its headquarters from Wray Castle to The Ferry House in the autumn of 1950 (Fritsch 1951)

⁴ John Lund described Wray Castle as ‘a Victorian monstrosity ill-designed for living in or, it seemed, working in’ (1984, 1).

⁵ FBA arch., Macan, T. T. nd Recollections of the Freshwater Biological Association, or what you will not find in the Annual Report. Unpublished paper.

⁶ FBA arch. Lowe eels files.

⁷ FBA arch. 168

⁸ Pearsall died in 1964.

⁹ FBA arch., Tutin, W, 2003 What I did, publications: 1937-2003. Unpublished paper.